Classification of Wild and Cultivated Wheat Strains Based on Their Leaf Structures

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Classification of Wild and Cultivated Wheat Strains Based on Their Leaf Structures

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Summary

Twenty strains of fifteen species of *Triticum* and *Aegilops* were classified into groups based on their leaf structure as observed in transverse sections.

Four distinct types were recognized:

1. The aegilopoides type (*T. aegilopoides* var. *boeoticum*) ..... A compact, thick, radiate arrangement of small mesophyll cells around the densely located vascular bundles was observed.
2. The speltoides type (*Ae. speltoides* Tausch, *Ae. squarrosa* var. *typica*, *T. dicoccoides* var. *spontaneo-nigrum*, *T. dicoccum* var. *liguliforme*, *T. persicum* var. *stramineum* and *T. turgidum* var. *nigro-barbatum*)..... The leaves are relatively thick, though rather loose in mesophyll compactness. Some mesophyll cells are radiate while some are non-radiate. The size of the mesophyll cells are relatively large.
3. The vulgare type (*T. vulgare* var. *erythrospermum*) ..... A loose, thin arrangement of larger mesophyll cells, many of them being non-radiate at the sparsely located vascular bundle intervals, was observed.
4. The macha type (*T. macha* var. *sub-letschumicum*)..... The leaves are relatively thin, however, compact in mesophyll cell arrangement. The size of mesophyll cells is smaller. The vascular bundles are densely located.

Strains of *T. monococcum* and *T. durum* were intermediate in leaf structure being between the aegilopoides and vulgare types, and the speltoides and vulgare types, respectively.

T. araraticum var. *tumaniani* was intermediate between the aegilopoides and speltoides types.

A scheme for grouping and systematization of wheat strains based on their leaf structure was also prepared.

The authors investigated the differences in leaf photosynthesis and related leaf characters among cultivated wheat species and their wild relatives (1, 2). In the present paper observations of the internal leaf structures are reported with photographs of the transverse sections.

A part of the observations was reported in a separate paper (3) with some

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discussions on the relationship between the leaf structures and the photosynthetic rates. However, we could not show the actual leaf structures of all the materials.

The materials consisted of a total of twenty strains of fifteen species of *Triticum* and *Aegilops*. They included diploid, tetraploid and hexaploid species of wild and cultivated types with winter and spring habits of growth (1). In this paper the authors attempt to classify these materials into groups based on their leaf structures as observed in transverse plane.

Materials and Methods

The plants grown in a greenhouse for the first experiment of this series (1) were used. The second and the third leaves of the seedling stage, and the second leaf from the flag leaf (n-1) were fixed in FAA, dehydrated with TBA, and embedded in paraffin. The middle portions of the leaves were sectioned at 15–25 μ in thickness in the transverse plane and at 10–12 μ in the longitudinal plane, and stained with safranin-fast green. In this paper only the structures of the second leaf from the flag leaf (n-1) are shown with photographs of the transverse plane.

Results and Discussions

Figs. 1–20 show the structures of the second leaf from the flag leaf (n–1) of twenty strains as observed in transverse plane. Differences were observed among strains in total leaf thickness, in the distance between bigger and smaller vascular bundles, in the number of smaller bundles between bigger bundles, in the development of bundle sheath extention, in the size of mesophyll cells, in the pattern of arrangment of mesophyll cells, in the compactness of the mesophyll cells, in the size and number of bulliform cells, etc.

However, some strains resembled each other. It can be pointed out that *Aegilops speltoides* (Fig. 1), *Ae. squarrosa* var. *typica* (Figs. 2 and 3) among the diploid strains and *T. dicoccoides* var. *spontaneo-nigrum* (Fig. 8), *T. dicoccum* var. *liguliforme* (Fig. 9), *T. persicum* var. *stramineum* (Fig. 11), and *T. turgidum* var. *nigro-barbatum* (Fig. 12) among the tetraploid strains as well as *T. compactum* var. *icterinum* (Fig. 16) and *T. spelta* var. *duhamelianum* (Fig. 17) among the hexaploid strains resembled each other in their leaf structure. The leaves of these strains were relatively thick, however, rather loose in their mesophyll compactness. Some mesophyll cells were arranged radiately around the vascular bundles and others were not, but located between the vascular bundles. The size of the mesophyll cells was relatively large as observed in the transverse plane. Because of such common characters, these strains can be classified into one group, tentatively called the "spelotides type".

Besides, there are two extreme types namely *T. aegilopoides* var. *boeoticum* (Fig. 4), a wild plant of diploid AA genome and *T. vulgare* var. *erythrospermum*

(Fig. 18), a strain of cultivated hexaploid AABBDD genome bread wheats, as mentioned in a separate paper (3).

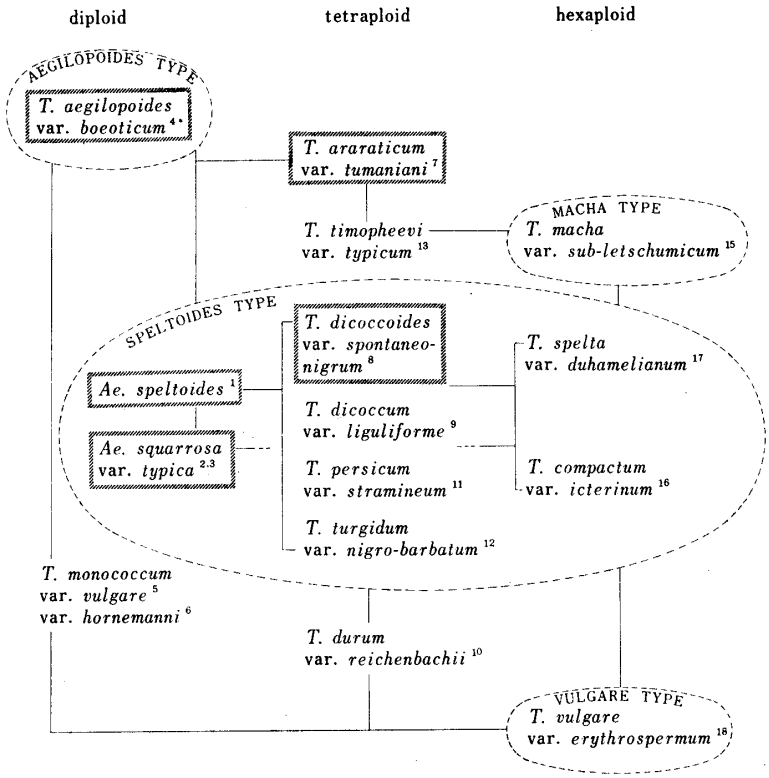
In the case of *T. aegilopoides* var. *boeoticum* (Fig. 4), almost all of the mesophyll cells were arranged radiately around the vascular bundles. The size of the mesophyll cells was comparatively small. The arrangement of the mesophyll cells seemed to be compact. In short it can be said that this type, called the "aegilopoides type" showed compact, thick, radiate arrangement of small mesophyll cells around the densely located vascular bundles.

On the contrary, in the case of *T. vulgare* var. *erythrospermum* (Fig. 18) many mesophyll cells were not arranged radiately but located between the vascular bundles. The size of the mesophyll cells was larger as compared with that of the aegilopoides type. The arrangement of the mesophyll cells seemed to be loose and showed a higher density in the intercellular spaces. In short, this type called the "vulgare type" showed loose, thin arrangement of larger mesophyll cells, many of them being non-radiate but found at intervals between the sparsely located vascular bundles.

In addition to these above stated three types, one more distinct type was also seen from the view point of its leaf structure namely the "macha type". The *T. macha* var. *sub-letschumicum* (Fig. 15), a hexaploid AABBDD genome wheat was of this type. The leaves of this type were relatively thin, however, compact in mesophyll cell arrangement. The size of the mesophyll cells was smaller than that of the speltoides and vulgare types. The vascular bundles of this type were close together.

The remaining strains involved in this investigation showed an intermediate leaf structure between the above stated types. *T. monococcum* var. *vulgare* and *hornemanni* (Figs. 5 and 6), cultivated einkorn wheats, resembling their wild relative, *T. aegilopoides* var. *boeoticum* (Fig. 4) in size and compactness of mesophyll cells, but in leaf thickness and in the arrangement of mesophyll cells they resembled *T. vulgare* var. *erythrospermum* (Fig. 18) to some extent. *T. durum* var. *reichenbachii* (Fig. 10) which prefers areas with mild climates among tetraploid wheats (4) is also similar. It resembled the *T. vulgare* var. *erythrospermum* (Fig. 18) to some extent when compared with the tetraploid wheats classified as the "speltoides type". *T. araraticum* var. *tumaniani* (Fig. 7) seemed to be an intermediate type of the aegilopoides and speltoides types. Further *T. timopheevi* var. *typicum* (Fig. 13) seemed to be in between *T. araraticum* (Fig. 7) and *T. macha* (Fig. 15). These two species *T. araraticum* and *T. timopheevi*, together with *T. macha*, are said to be growing or grown only in Transcaucasia (4, 5).

The two Japanese cultivars of bread wheat, *T. vulgare* Akagawa-aka (Fig. 19) and Konosu-25 (Fig. 20) can be classified in the "vulgare type". However, among them, Akagawa-aka, a winter variety, showed a little more compact leaf structure than the *T. vulgare* var. *erythrospermum*; resembling *T. macha* to some



SCHEME 1. Grouping and systematization of wheat strains based on their leaf structure. *T.*: *Triticum*, *Ae.*: *Aegilops*, *: Plant number, ▭: wild strain.

extent. The varietal differences in common wheats were dealt with in a separate paper (3).

Scheme 1 is a diagrammatic representation of the above stated grouping and systematization of the strains observed excluding the two Japanese cultivars.

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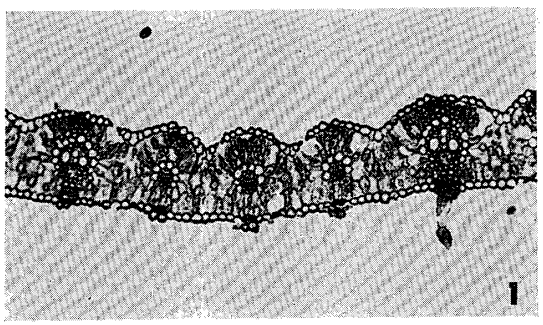
Plate 1

Explanation of Figures

FIG. 1. *Aegilops speltoides* Tausch: diploid, wild, spring.
FIG. 2. *Ae. squarrosa* var. *typica*: diploid, wild, winter.
FIG. 3. *Ae. squarrosa* var. *typica*: diploid, wild, spring.
FIG. 4. *Triticum aegilopoides* var. *boeoticum*: diploid, wild, winter.
FIG. 5. *T. monococcum* var. *vulgare*: diploid, cultivated, winter.
FIG. 6. *T. monococcum* var. *hornemanni*: diploid, cultivated, spring.
FIG. 7. *T. araraticum* var. *tumaniani*: tetraploid, wild, winter.
FIG. 8. *T. dicoccoides* var. *spontaneo-nigrum*: tetraploid, wild, winter.
FIG. 9. *T. dicoccum* var. *liguliforme*: tetraploid, cultivated, spring.
FIG. 10. *T. durum* var. *reichenbachii* :tetraploid, cultivated, spring.

Transverse sections of the second leaves from the flag leaf (n-1). ×60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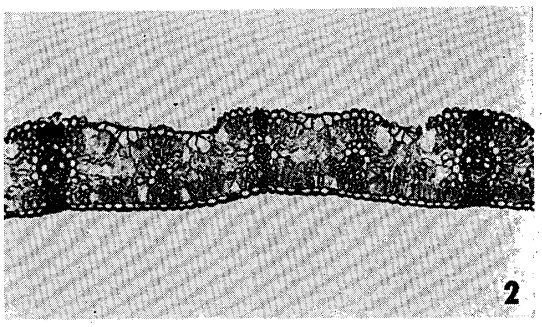
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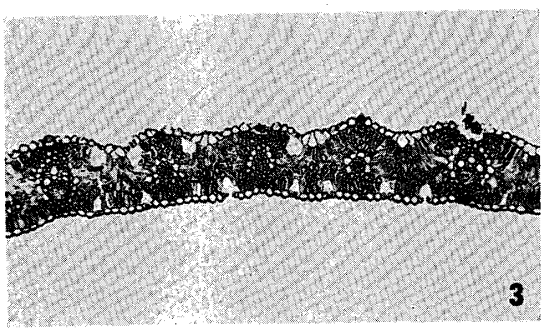
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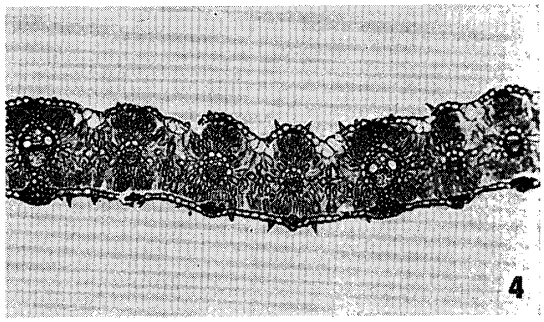
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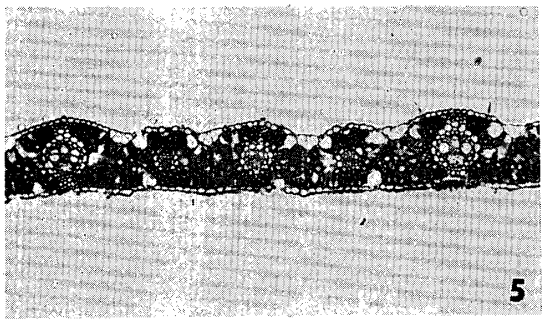
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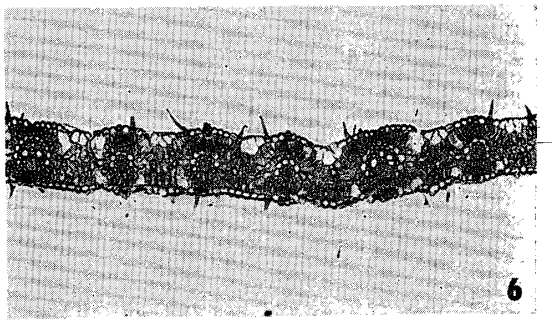
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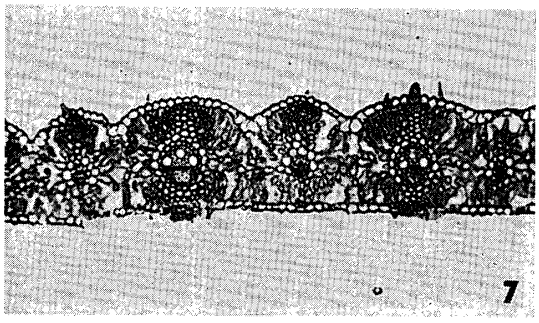
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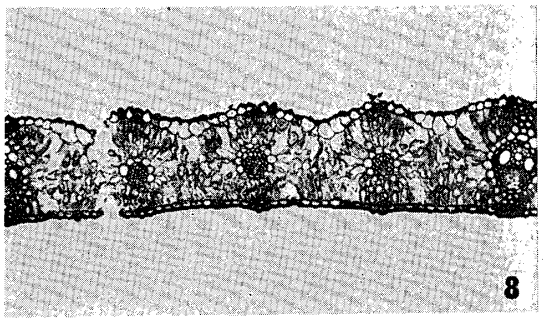
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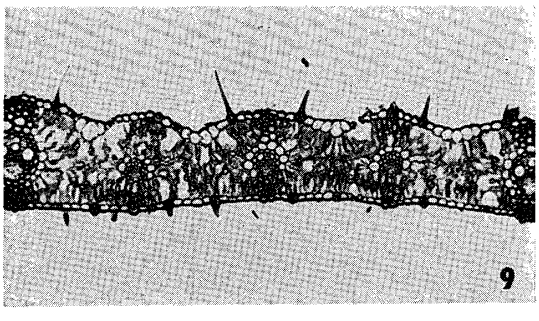
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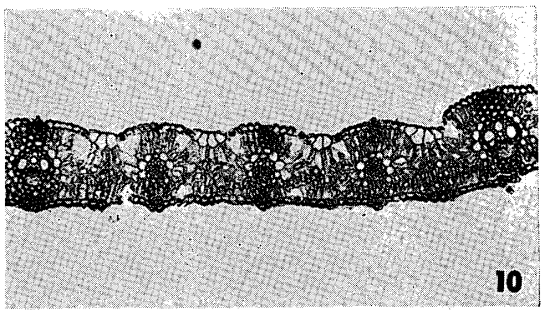
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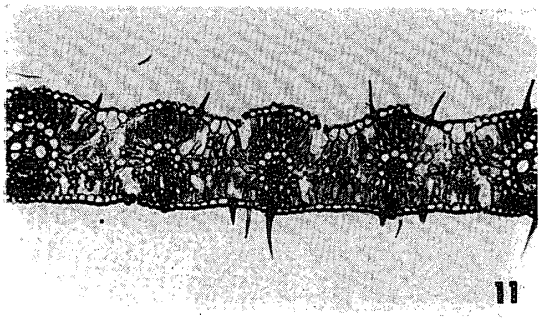
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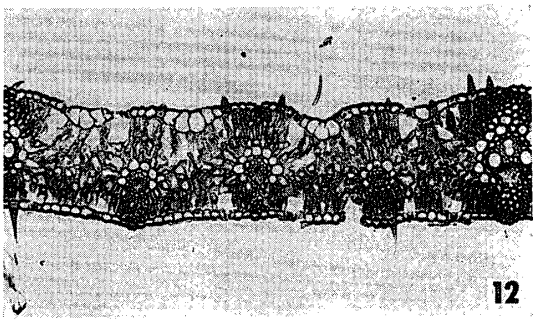
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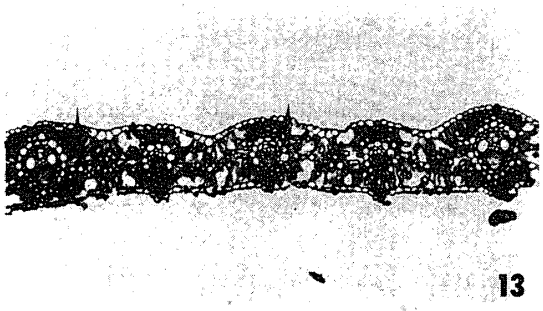
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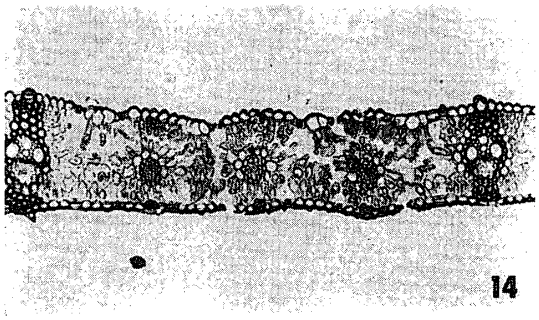
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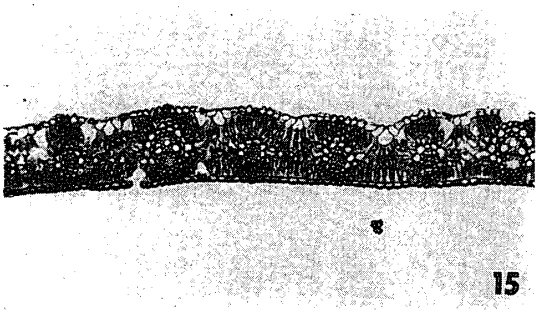
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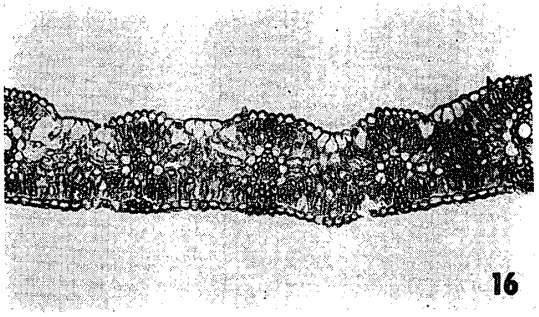
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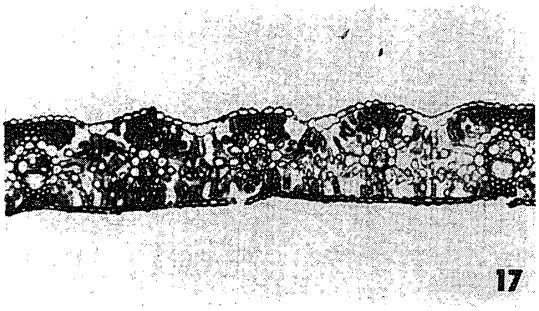
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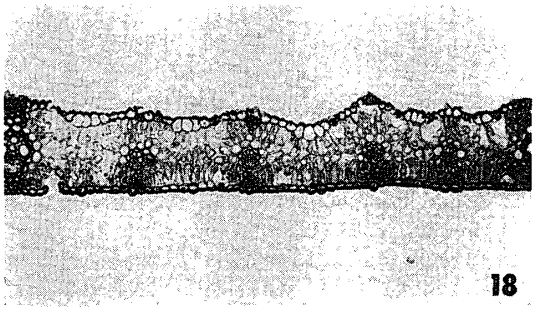
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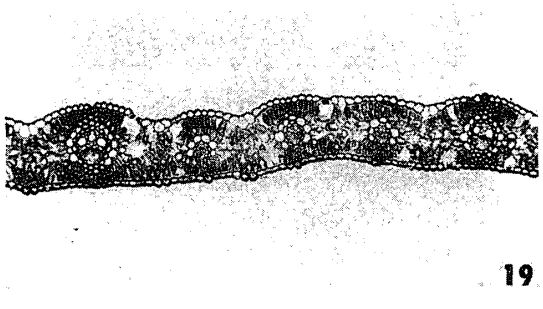
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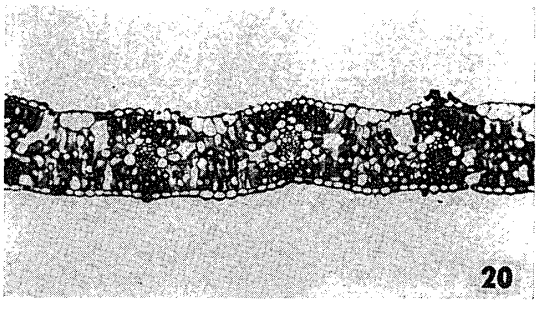
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Plate 2

Fxplanation of Figures

FIG. 11. *T. persicum* var. *stramineum*: tetraploid, cultivated, spring.
FIG. 12. *T. turgidum* var. *nigro-barbatum*: tetraploid, cultivated, spring.
FIG. 13. *T. timopheevi* var. *typicum.*: tetraploid, cultivated, spring.
FIG. 14. *T. dicoccoides spontaneo-nigrum* × *Ae. squarrosa*, Amphi diploid.: hexaploid, wild, winter.
FIG. 15. *T. macha* var. *sub-letschumicum*: hexaploid, cultivated, winter.

FIG. 16. *T. compactum* var. *icterinum*: hexaploid, cultivated, spring.
FIG. 17. *T. spelta* var. *duhamelianum*: hexaploid, cultivated, spring.
FIG. 18. *T. vulgare* var. *erythrospermum*: hexaploid, cultivated, spring.
FIG. 19. *T. vulgare* cultivar. Akagawa-aka: hexaploid, cultivated, winter.
FIG. 20. *T. vulgare* cultivar. Konosu-25: hexaploid, cultivated, spring.

Transverse sections of the second leaf from the flag leaf (n-1). ×60